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IMPLEMENTATION OF LEAN SIX SIGMA IN INDIAN HEALTHCARE INDUSTRY TO REDUCE DISCHARGE CYCLE TIME

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ABSTRACT

In the present focused market, organizations are searching for beat line development and chances to diminish their aggregate cost structure. The senior administration of such organizations might want to build quality, effectiveness, and ability without expanding capital speculation. The Six Sigma DMAIC critical thinking procedure and Lean thinking offers the more noteworthy effectiveness and ability to compose the organization procedures of business. To make nonstop development and progress in the present market about each business procedure needs change. Change implies expanding On Time Shipment (OTS), expanding stock turnover, lessen add up to operational hours per unit, diminish prepare variety and cost, and enhancing the quality. By enhancing the business forms, we can accomplish these progressions. The act of Lean strategies focuses to waste decrease; Six Sigma procedure focuses to lessen process variation.

This report investigates and actualizes the Lean Six Sigma procedures, apparatuses, and strategies in healthcare industry. The benefit of application of Lean Six Sigma is that it will lessen entire cost of set-up, develop supply chain proficiency, and increase customer fulfillment. This study validated the use of Lean Six Sigma DMAIC methods to reduce the discharge cycle time of hospital. Despite the fact that the normal discharge time diminished from 150.41 minutes to 94.84 minutes showing 36.84% decline.

keywords: *HEALTH CARE, INVENTORY, LEAN, SIX SIGMA..*

I. INTRODUCTION

In India population is increasing day by day so the demand of the bed to avail the hospital facility is also increasing. As per the data from world health organization, it is visible that the demand of bed in 2011-12 is 1.4750 million. It is increased up to 1.7 million in 2015-16. A/c to world health organization India requires 3.7 million beds and 3 million doctors by 2034.A fundamental problem of India's health service is the lack of bed availability. The rapidly growing burden of population in India, Long waiting time and Long Discharge cycle time makes lack of bed availability. A long, inefficient system for discharging patients is an average stress for the healthcare offices in India. Long discharge cycle time or 'bed blocking' are terms used to depict the inappropriate occupancy of hospital beds. Delay in releasing surgical patients from hospital facility is a long-standing and basic issue. Long discharge cycle time or wasteful discharging process affect clinics' capacity to cut waiting records and convey healthcare effectively and productively. In intense healthcare centers, delayed length of stay (LOS) expands cost, as well as related with expanded rates of complications(World Health Organization, 2010).

There is a need to search for new and more effective methods for providing care. Numerous human services associations receive the Toyota production system as the execution change approach, frequently called the Lean healthcare management. In the USA, some clinic directors found that Lean and Six Sigma could help them to deal with to take care of financial issues and lessen the procedure mistakes they were encountering (Sugimori et al., 1977).

Lean Sigma are methodologies that were made to manage particular requirements of organizations, to make them aggressive and in addition advantageous, both utilizing distinctive ideas and techniques, however having a similar target: a constant change procedure.Their incorporation (alongside their results) in different fields like municipal services, finance, military etcetera, imply a fantastic chance toacquire another field: medicinal services. From this, few healing facilities over the US have propelled their own tasks utilizing Lean standards as well as Six Sigma (Dellifraine et al., 2010).

II. LITERATURE REVIEW:

A lot of existing literature review articles is accessible on the standalone ways of lean methodology and Six Sigma methodology; however accessibility in the coordinated structure is in rare supply. Still a few endeavors have been made by the researchers in the past to arrange and recreate the current situation of LSS.

2.1 Definitions of Lean Six Sigma

Table 1: Lean six sigma definitions by different authors

Author	Definitions
(Anderssonet al.,2014)	Lean Six Sigma is an integrated vital strategy that enables companies to meet and exceed customer expectations in a changing and competitive global environment.
(Thomas and Barton, 2011)	Lean Six Sigma is a quality change strategy that empowers to carry out the advantages of waste lessening and responsive manufacturing offered by lean with creating powerful, error free and fault tolerant production offered by Six Sigma.
(Salah *et al. ,20010)*	Lean Six Sigma is a philosophy that focuses on the disposal of waste and variety, taking after the DMAIC structure, to carry out consumer satisfaction and better money related results for the business as to quality, conveyance and cost.
(Snee, 2010)	Lean Six Sigma is a business strategy and method that increases process performance resulting in enhanced customer satisfaction and improved bottom-line results.
(Assarlind et al., 2014)	Lean Six Sigma utilizes devices from both tool kits to get the best from the two method, expanding speed while additionally expanding accuracy.
(Besseris, 2014)	Lean Six Sigma (LSS) is modern business magnificence activity that offers an awesome abundance of continuous improvement tools and ways to combat process insecurities and product breakdown.
(Corbett, 2011)	Lean Six Sigma is a hybrid procedure that associations embrace for managing high production rates and high quality, or diminishing waste in their procedures.

2.2 Lean Six Sigma in Healthcare

Chiarini and Bracci,(2013) looks at methods for using lean Six Sigma in healthcare associations. The writers talk about the suggestions of their examination for professionals (supervisors furthermore, doctors) and present a motivation for future exploration. In the first place in the UK, the National Health Service (NHS) has connected both Six Sigma and Lean. Lean Six Sigma extends in medicinal services have to a great extent focused on coordinate care transport, managerial help and monetary organization. The purpose has been to enhance medical procedures, to recognize and abolish waste from patient paths, to empower workforce to look at their individual working environment, expand value, security and effectiveness. The purpose of lean sigma is to increase the working efficiency, the time with patients and diminish the time on paperwork and waiting lists in healthcare.

Chiarini (2012) directed a case study for distinguish the CTQ for security and health dangers to medical attendants and doctors who manage cancer drugs in department of an Italian public hospital. The outcomes uncovered that there are two CTQ process: A). the transportation of medications from one division to other division. B) The inventory of medications in the diverse department. After dispensing with the two procedures, group ascertains the six day reduced in lead time and 60% in transportation and movement of medications.

Cima et al. (2011) conducted a case study to enhance working room productivity or efficiency academic medical center use of Lean and Six Sigma Methodology. Their gauge surgical site infection (SSI) rate in the vicinity of 2009 and 2010 was 9.8%. One year after usage of the SSI decrease package, they showed a huge diminishment (P<.05) in both generally speaking and shallow SSIs, to 4.0% and 1.5% separately.

Pocha (2010) conducted a case study at a Veterans Affairs Medicinal Center utilization of LSS. After implementation of LSS the results revealed that CTQ process is the Quantity of Portable Chest X-rays in the Emergency Room. After execution of LSS, Mediations have diminished pointless Portable Chest X-rays in the ED by 9% from benchmark. Contingent upon ED volume, their mediations would save the ED from $5,974 to $10,303K every year.

Fairbanks (2007) conducted a case study Utilizing lean six sigma DMIAC tool for improve patient flow or patient throughput in healthcare environment. There are CTQ process is holding time, in medicinal services 40.38% of cases take longer than10 minutes for holding time. Utilizing lean six sigma Hold up times before surgical methodology enhanced 2.4 focuses (i.e., a score in light of rate) from 85.7 to 88.1. Communication time or information time improved 2.3 focuses from 85.9 to 88.2. Staff individuals co-operated enhanced 1.4 focuses from 95.8 to 97.2 with measurably critical additions at a .05 confidence level. The overall facility rating improved 1.2 points from 93.2 to 94.4, and ambulatory overall scores improved from the 84th percentile to the 97 the percentile.
Niemeijeret al. (2010) led a case study for enhancing the discharge method of patients utilizing lean sigma in University Medical Center Groningen. In 2006 and 2007, the University Medical Center Groningen was not generally fit for conceding all injury patients to the TND because of the moderately high-bed occupation. The normal LOS of injury patients at the TND toward the start of the project was 10.4 days. Thirty percent of the LOS was superfluous. The fundamental driver of the long hospital stay was delay in a few zones. The execution of the change plan diminished very nearly half of the unseemly healthcare stay, empowering the injury focus to concede all injury patients to the TND. After the execution of the upgrades, the normal LOS was 8.5 days.

Kuo et al.(2011) conducted a case study to propose a new model called Medicinal Services Lean Six Sigma Framework that incorporates Lean and Six Sigma systems to enhance work process in a post anesthesia care unit. Endeavors can be made to enhance work process what's more, lessen length of stay from 95 to 40 minutes, and the financial budget for the change is $600 000.

Vijay (2014) conducted a study using six sigma DMAIC methodology in the following two objective (i) First one is to reduce the time interval between discharge order conformed by physician and the final dues paid by the patient. (ii) the second one is to find out and eliminate which aspect of the ongoing process is taking more time. By implementing the six sigma process over the period of 2 months, the data was collected regarding the cycle time of the process to discharge the patient. By this process it is found that the overall time was reduced from 234 minutes to 143 minutes within a decrement of 61%.

III. RESEARCH FINDING

DMAIC is a data-driven quality strategy used for continuous improvement. It consists of five interconnected phases forming the DMAIC cycle that are: Define, Measure, Analyze, Improve and Control. It can be thought of as a roadmap towards process improvement by means of quality management and statistical tools. DMAIC projects strive to reduce variation so that the improved target for performance can be attained. Within each phase there are specific tools that are put into use during DMAIC as will be the case throughout this project for improving the efficiency and productivity of healthcare. A project begins by defining the problem to be addressed followed by measurement of the process baseline in the current state. Then, the data obtained is analyzed to determine the aspects that should be improved. Finally, at the end of the DMAIC cycle is the control phase that is concerned with monitoring and maintaining the improvements post-solution implementation. Thus, in the case of critical to quality (CTQ) process for the Healthcare system, the DMAIC cycle will be an integral part of project structure as well as the use of its principles, practices and tools within each of its phases.

3.1 Define Phase

The survey questionnaire methodology is extensively used method across the globe. The survey questionnaire methodology is used to collect data from the hospital. The survey questionnaire was prepared from the patient experience survey after some brainstorming. The questionnaire used for the survey is shown in the appendix 1. This questionnaire is used to assess the level of problems of patient in the hospital. The survey questionnaire was made up of two parts, one part providing the demographic information like name, age, diseases. And other part consisted of questions related to critical to quality for hospital. 100 randomly selected patients from various hospital of Jaipur city of Rajasthan participated in the survey. The respondents were given clear instruction regarding the seriousness and honesty in answering the questions. The data collected through the questionnaire provided following information.

Table 2: Survey response by patient

CTQ	No. of Response	Cumulative	% Cumulative
Long Wait for Discharge	72	72	26.76
Long Waiting Time	50	122	45.35
Accuracy of Diagnosis.	25	147	54.64
Testing and Report Turnaround	25	172	63.94
Treated Rudely by Staff	20	192	71.37
Wheelchair Unavailable	18	210	78.06
Parking Inconvenient	17	227	84.38
Medicine Shortage at Medical	15	242	89.96
Problem Related to Canteen Food	14	256	95.16
Bed Unavailable	13	269	100

Data in table 2 reveals the overall services level of hospital is not good. As it was 72 no. of response for the long wait for discharge and 50 no. of response for the long waiting time. The survey was designed to help identify problems, not to Provide solutions. A Pareto chart is a bar chart for categorical data in which categories are presented in descending order of frequency. Then constructed a Pareto chart to indentify the main problem.

Figure 1: Pareto chart of CTQ factor

A Pareto chart illustrates that80% of observed defects or problems can be attributed to 20% of the causes. This sometimes is referred to as the 80-20 rule. In Figure 8, the highest frequency bars make up the bulk of the

Categorical data (i.e. defect). Case long wait for discharge was the most frequent factor. This represents the "vital few" factor influencing the system.

3.2 Measure Phase

The measure stage includes documentation and assessment of the current Patients release framework before usage of the Improvement system that the lean six sigma approaches recommend. The procedure is beginning from the release choice taken by the Physician and closures with the auspicious bill paid by the patient and leave room. It was separated into six legitimate sub forms viz:-

Process A: Confirmation of discharge, written discharge order by the physician; Process B: Adding the necessary laboratory reports with discharge order and education of patient by the RN; Process C: Typesetting of the rough bill and add in Discharge report by the Clerk; Process D: Completion of the final Discharge report the Clerk after correction byphysician; Process E: Discharge report ready to be handover to the patient after signed by the physician; Process F:Bill paid by the patient and leave room.

A time study was utilized to gauge each progression in the process to decide the time devoured by each of the six sub forms towards the planning of the discharge procedure. Time think about is an immediate and consistent perception of an undertaking, utilizing a timekeeping gadget (e.g., decimal moment stopwatch, PC helped electronic stopwatch, and tape camera) to record the time taken to finish a task.

The discharge cycle time defined from the time physician discharge order was submitted to time patient left the hospital. In Lean six sigma methodologies, process performance is depended on six sigma level of organization.

Table 3: Total time of a sub process of Discharge procedure

Patient	Process A	Process B	Process C	Process D	Process E	Process F	Mean time
1	40	30	30	15	15	20	150
2	47	35	25	20	25	15	167
3	55	28	24	18	30	20	175
4	35	27	30	20	15	20	147
5	50	30	20	15	30	15	167
6	53	26	20	15	20	25	159
7	59	34	25	29	15	20	172
8	56	38	24	22	17	19	176
9	61	39	35	15	16	14	180
10	54	43	39	17	14	14	181
11	62	62	44	20	15	17	196
12	50	50	40	15	20	15	175
13	51	51	34	17	19	17	166
14	40	40	30	15	15	20	150
15	44	44	35	20	20	17	161
16	55	55	26	18	30	20	175
17	35	35	22	20	15	17	116
18	33	33	22	17	15	18	116
19	40	40	32	20	16	19	143
20	49	49	28	15	17	20	141
21	40	40	17	10	18	22	147
22	51	25	16	12	20	18	142
23	37	28	15	14	17	17	128
24	42	35	14	17	16	16	140
25	35	40	18	18	22	18	151

26	30	24	17	20	14	23	136
27	40	34	22	15	15	17	143
28	35	22	14	20	15	10	116
29	32	22	14	10	12	13	132
30	40	23	20	20	14	15	103
31	49	24	18	13	17	14	135
32	40	27	17	10	18	22	134

The higher the six-sigma level then the higher will be the process. Data contained in the above table 3 is used for process capability analysis to determine the sigma level and statically measurement through the Cp,Cp_k,Pp and P_{pk}. Process capability on the discharge process was completed as shown in figure 9 Based on the upper specific limit 125 min and lower specific limit is 80 min. A/c to process capability analysis the baseline total mean process time 150.41 min.

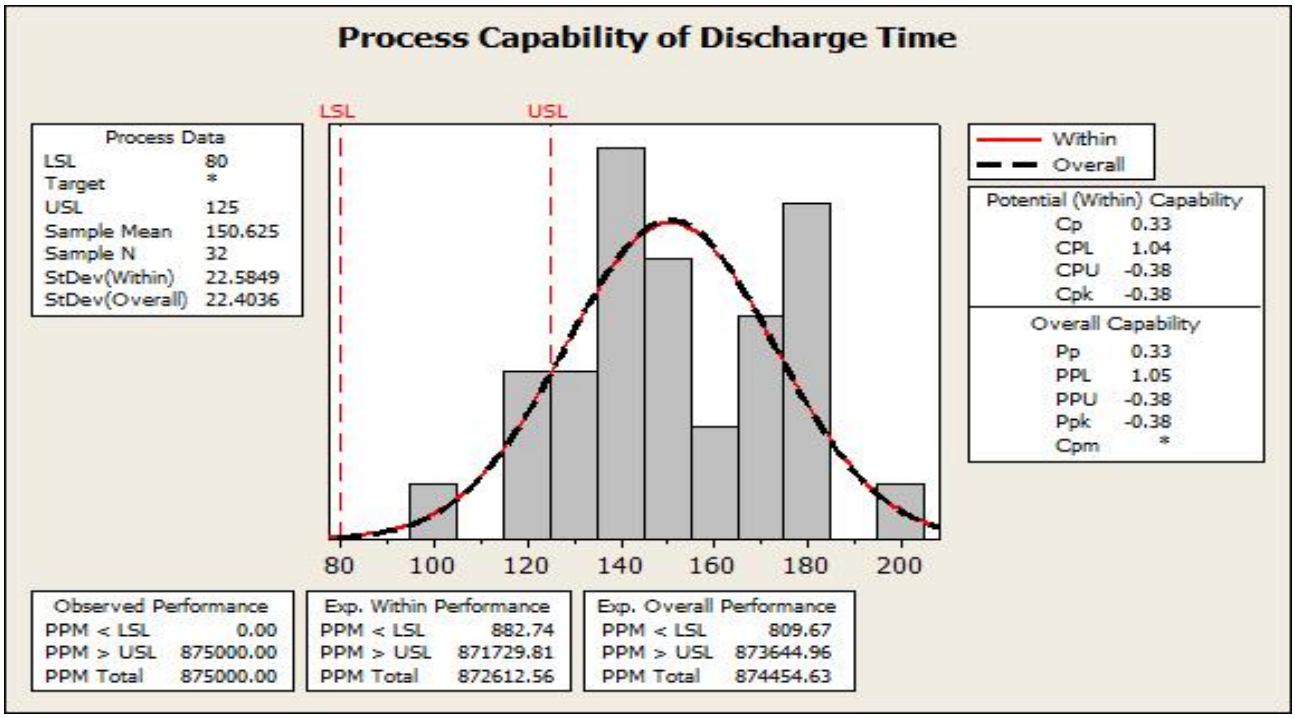

Figure 2: process capability before improvement

According to figure 2 there are lot of variation because the mean time is the out of the range because Cp= 0.33 and Pp= .33. Standard deviation was found to be 22.58 min so that the discharge was found to be run at a 0.352 six sigma level. Since a good process run at 6-sigma level this allowed for money improvement.

3.3 Analyze Phase

A brainstorming exercise was undertaken by an interdisciplinary group of doctors, ground staff, clerk, patient family member etc. at the hospital in order to identify potential factors that could influence long discharge time. As the final part of the analysis, the team created a fishbone diagram utilizing both the qualitative and quantitative data from observations to identify the drivers of waste and variability.

This diagram is located in fig.4 the team separated the deriver into five different categories. Categories include the physician, the clerk, the nurse, the discharge planner, patient, and transportation issues. Each of the categories contains issues which act as the symptoms that cause an inefficient discharge process. The identification of these

symptoms serves to surface the underlying problems, which in effect allows solutions to be implemented in the future.

Lean waste and fishbone analysis shows that major problems related to discharge issues as faced by patients in the private Hospital are found to be as follows:

Responses concerning the lack of standardization:
On several occasions the physicians, nurses, and clerks stated that the way they carry out their tasks may not be the same as the way others carry out the same tasks. Lacking of online data, Due to this updating of all record

know their duty. the entire patient cannot be flow to any person like Doctor, Nurse, or receptionist. Now the result is no one can

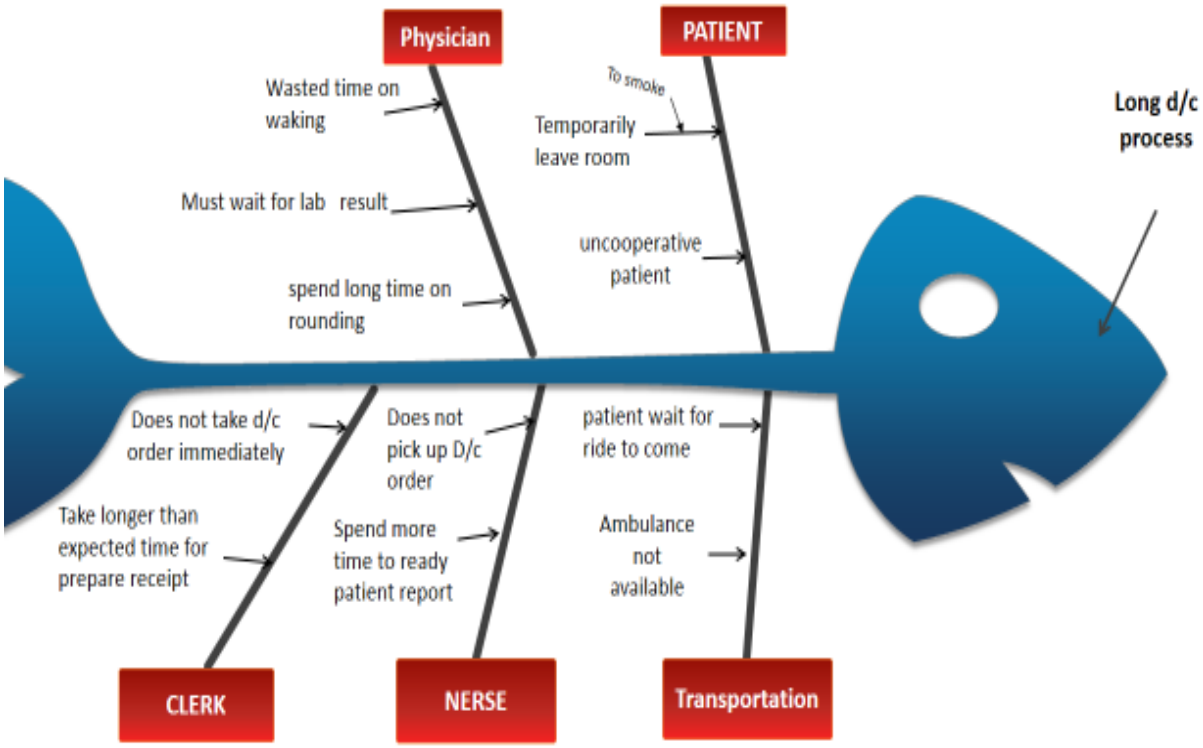

Figure 3: Fishbone Diagram

Responses concerning shift change:
Patients are often ready to be discharged near the end of the nurse's and/or clerk's shift. This can lead to delays because the nurse and/or clerk may not be able to stay beyond the length of their shift to complete the discharge. In this case, the patient information must be handed off to the replacing shift. It is believed that this handoff process delays the discharge. In addition, the patient and nurse may not be familiar with one another which can be inconvenient for each person.

Responses from the patients:
The patients were told early in the day that they would be discharged but had to wait until any transportation arrange and a lengthy discharge due to patients that were uncooperative with the doctor, RN and billing staff.

Responses from the clerks:
Many discharges occur around the same time in the day. Because of this, the clerk's receive many tasks in a short amount of time. This can hold up the discharge process and, in addition, can be overwhelming for the clerk.

Many times when the clerk goes on lunch break nobody takes over their tasks. Anything that is not urgent is put off until the clerk returns. If a physician or nurse needs the clerk to perform a specific task, the physician or nurse must ask the other clerk or do it themselves.

Additional responses from the physicians:
The physicians would like to have a designated place to write orders.Each physician has his or her own priority in seeing patients (after the most critical are first seen).

3.4 Improve Phase
We decided to take the following steps to streamline the Discharge process:

- After implementation of online module update the inpatient files on a daily basis and the Provision for the same was provided at each Patient care department.
- The Billing module, laboratory module, and medical module was also integrated with the each other module and hence any entries made in the laboratory module and medical module, the entries were reflected in the Billing module as well.
- The laboratory module was also connected with the Clinical module so that all laboratory report available at one place on the system of receptionist.

The measure stage includes documentation and assessment of the current Patients release framework after usage of the Improvement technique that the lean six sigma philosophies propose. The procedure is beginning from the release choice taken by the Physician and closures with the Bill paid by the patient and leave room. It was separated into four legitimate sub forms viz:

Process A: Confirmation of discharge, written discharge order by the physician; Process B: Education to patient by RN; Process C: Print all bill and laboratory report from online module by receptionist. ; Process D: Discharge report ready to be handover to the patient after signed by the physician; Process E: Bill paid by the patient and leave room. A period thinks about was utilized to gauge each progression in the process to decide the time devoured by each of the five sub forms towards the planning of the release synopsis.

Table 4 : Total time of a sub process of Discharge procedure after improvement

patient	Process A	Process B	Process C	Process D	Process E	Mean time
1	30	15	20	12	10	87
2	25	12	17	19	14	87
3	27	13	16	14	13	83
4	40	14	14	13	17	98
5	25	16	13	12	14	80
6	26	17	15	4	20	92
7	28	18	14	16	22	98
8	30	20	20	12	20	102
9	29	22	18	10	14	93
10	27	23	17	14	16	97
11	30	15	20	12	10	95
12	37	20	14	13	13	97
13	36	16	13	9	20	94

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14	32	14	12	12	22	92
15	31	12	20	10	10	83
16	28	14	15	9	15	81
17	29	12	17	15	8	81
18	32	18	16	13	12	91
19	35	17	22	14	13	101
20	27	16	18	16	14	91
21	28	15	15	12	20	90
22	30	14	18	18	17	97
23	32	20	16	14	18	100
24	34	20	20	13	23	110
25	35	18	22	20	28	123
26	36	17	15	22	17	107
27	37	16	13	14	16	96
28	38	15	15	15	14	97
29	39	13	18	16	18	104
30	29	14	17	12	14	86
31	36	18	16	18	19	107
32	30	20	13	12	20	95

The above table contains the data after implementation of improvement in the discharge process of hospital. This data is used in the process capability analysis of improving discharging process.

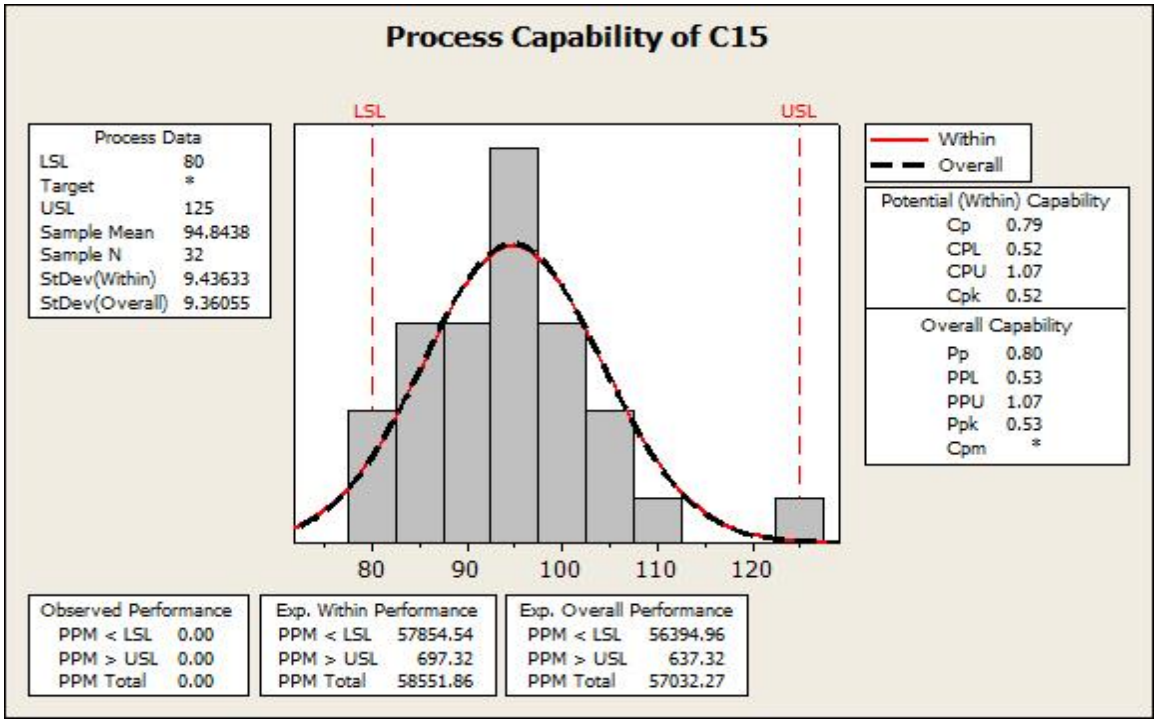

Figure 4 : process capability analysis after improvement

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The process capability analysis shows in figure. After this analysis, the values of various parameters are as follows: mean discharge cycle time = 94.84, standard deviation = 9.31, process sigma level = 3.080, Cp = 0.79. By applying process capability analysis, the value of mean discharge cycle time is within the range and sigma level also improved which shows that the systems efficiency has been improved from previous analysis.

3.5 Control Phase

The Control phase is the last part of the DMAIC cycle. In this phase after the improvements have been implemented it is important that the process is continuously monitored to ensure that the improvements in Discharge process are persistent in the future beyond the span of the project.

Thus, the authors will bring forth the aspects that should be monitored by the stakeholders so that the improvement benefits can be maintained once the project results are handed-over. There will be main focuses for the control phase that are a means for monitoring the new process performance standards in terms of productivity and efficiency. A control chart is mapped with the 32 observations in which then upper limit is 125 min and lower limit is the 80 min and it is found that all the observation are under these limit which shows that the system is efficient.

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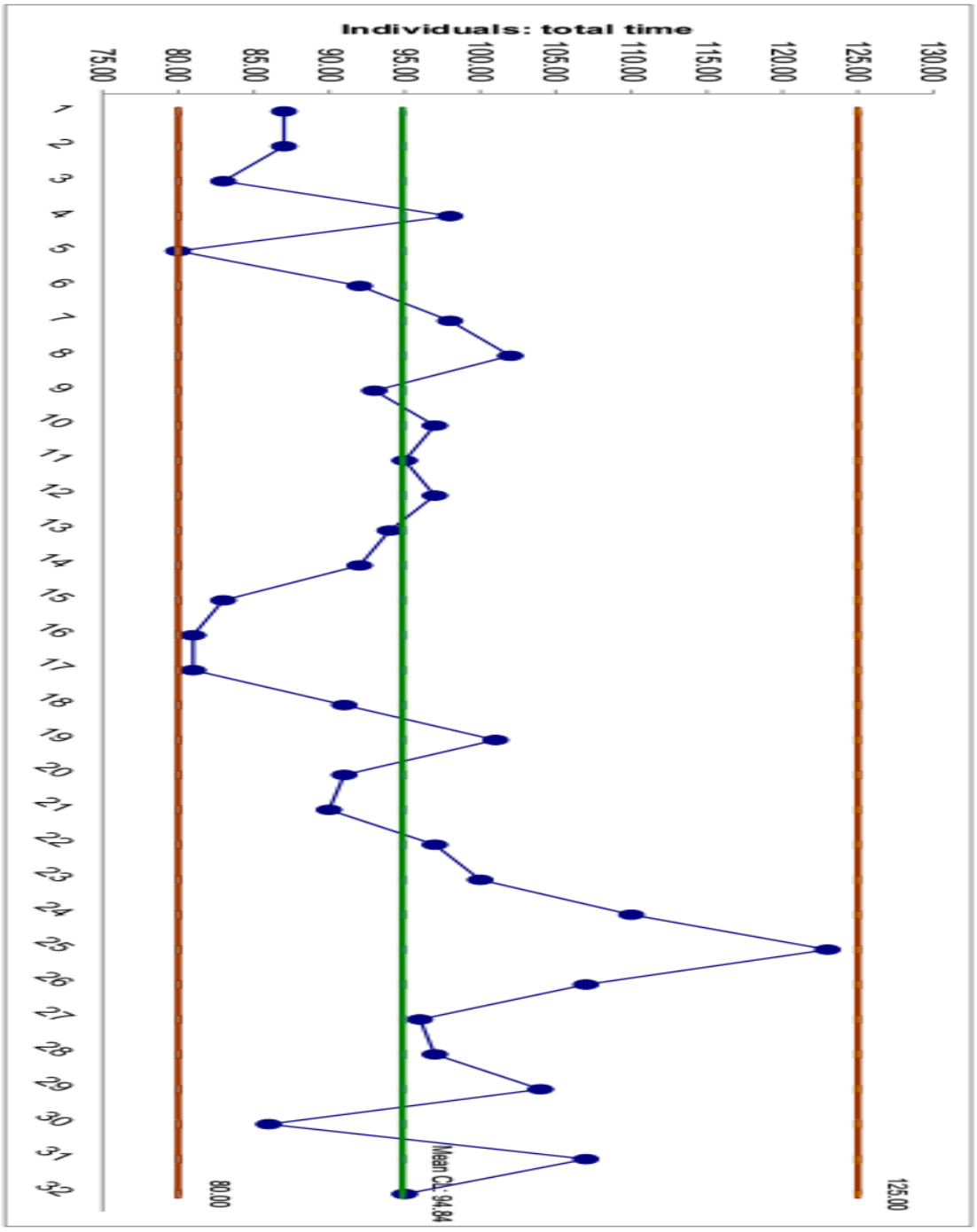

Figure 5: Control chart

IV. CONCLUSION

The project has been carried out in the form of a DMAIC cycle typically used for continuous improvement efforts within Lean Six Sigma. However, in this case the goal of the project was to use the DMAIC cycle as foundation for

project structure and problem analysis towards creating an improved performance level. The perspective taken towards the discharging process was threefold, namely in terms of time variation (Mura), and lack of standardised. The tools used in the define phase were effective when converging to a more specific problem focus. Moreover, the quality improvements tools used in the measure and analyse phase Proved to be valuable for breaking down the problem at hand into several perspectives during the study.

This research study confirmed the use of Lean Six Sigma DMAIC approaches to decrease the discharge cycle time of hospital. Despite the fact that the normal discharge time diminished from 150.41 minutes to 94.84 minutes showing 36.94% decline.

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